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Reaction times and reflection in social dilemmas:

Extreme responses are fast, but not intuitive

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Abstract

When people have the chance to help others at a cost to themselves, are prosocial decisions reached more quickly (and intuitively) than selfish decisions? Emerging experimental evidence suggests that cooperation is intuitive, but studies have reported both positive and negative correlations between reaction times and cooperation. To reconcile this apparent contradiction, we investigate whether reaction times follow an inverted-U pattern, with extreme decisions occurring more quickly than intermediate decisions. Studies 1-3 find robust support for the inverted-U pattern: intermediate decisions took longer than both extremely selfish and extremely cooperative decisions. This might suggest that extreme, rather than cooperative, decisions are intuitive; however, experimentally manipulating intuitive (vs reflective) processing shows that this is *not* the case. Promoting reliance on intuition through time pressure (Study 4) or cognitive priming (Study 6) increased the frequency of cooperative decisions, but *decreased* the frequency of selfish decisions. Given this dissociation between correlation and manipulation, reaction times should not be taken as a direct proxy for the use of intuitive or reflective processes. Rather, we develop the idea that decision conflict helps to explain individual differences in reaction times (Studies 5 and 6): feelings of conflictedness were positively correlated with both reaction times and frequency of intermediate decisions; reaction times mediated the relationship between conflict and intermediate decisions; and feelings of conflictedness were unaffected by the manipulation of intuitive processing.

Reaction times and reflection in social dilemmas:

Extreme responses are fast, but not intuitive

Does cooperation occur intuitively, or does the decision to help others require reflection? For organizations and societies to effectively promote prosocial behavior, it is important to understand if selfish decisions are made in the heat of the moment (Loewenstein, 1996) or if they require calculated planning (Machiavelli, 1532/1964). Psychologists and economists have applied dual-process theories of decision-making (Chaiken & Trope, 1999; Kahneman, 2011; Sloman, 1996; Stanovich & West, 2000) to explain behavior in social dilemmas, using both experimental manipulations of cognitive processes and correlational studies of reaction times to infer whether cooperation is based on intuitive or reflective processes (Verkoeijen & Bouwmeester, 2014; Zaki & Mitchell 2013). Converging *experimental* evidence supports the claim that cooperation, on average, is intuitive (e.g. Rand et al., 2014), but *correlational* studies testing the relationship between reaction times and cooperation have produced conflicting results. Some studies have found that cooperative decisions are faster than selfish ones (Cappelen, Nielsen, Tungodden, Tyran, & Wengström, 2014; Lotito, Migheli, Ortona, 2013; Nielsen, Tyran, & Wengström, 2014; Rand, Greene, & Nowak, 2012), while other studies have reported different patterns (Fiedler, Glöckner, Nicklisch, & Dickert, 2013; Piovesan and Wengström, 2009).

Previous correlational studies have focused on a linear relationship between cooperation and reaction times. However, research from cognitive and social psychology suggests that reaction times generally follow an inverted-U pattern (Akrami, Hedlund, & Ekehammar, 2007; Austin, 2009), with extreme responses occurring more quickly than intermediate ones. We test the hypothesis that both extremely cooperative and extremely selfish responses occur quickly, with intermediate responses requiring the most time. We also examine the role of intuition versus

reflection in causing such a pattern, testing whether intuitive processing generally encourages extreme, rather than cooperative, responses. Finally, we address whether psychological variables other than the degree of intuition versus reflection, such as feelings of conflictedness, also influence the speed of decision-making in social dilemmas.

Intuitive cooperation in social dilemmas

Social dilemmas are situations that involve a conflict between self-interest and the collective good (Rand & Nowak 2013; Van Lange, Joireman, Parks, & Van Dijk, 2013). In the typical dilemma, the decision to cooperate is beneficial for the collective and costly for the individual. Social dilemmas are ubiquitous in social decision-making and occur in the contexts of close relationships, organizations, and societies at large. Researchers in the social sciences have extensively studied the psychology of social dilemmas using the Prisoners Dilemma (PD) and Public Goods Game (PGG), basic economic situations that measure the willingness to cooperate with a specific partner and a group, respectively.

Recently, psychologists and economists have investigated the cognitive underpinnings of cooperation in social dilemmas by applying the framework of dual-process theories, which distinguish between intuitive and reflective modes of decision-making (Chaiken & Trope, 1999; Kahneman, 2011; Sloman, 1996; Stanovich & West, 2000). Intuitive processes tend to be fast, automatic, effortless, and emotional. Reflective processes are slow, controlled, effortful, and based on calculative reasoning. A decision is intuitive insofar as it occurs quickly and is not affected by the availability of time and cognitive resources (e.g., manipulations of time pressure and concurrent cognitive load tasks).

There is emerging, interdisciplinary evidence that humans are intuitively cooperative and reflectively selfish (Zaki & Mitchell, 2013). When deciding how to share resources within a

group, responses under cognitive load are egalitarian, whereas more reflective decisions favor self-serving distributions (Roch, Lane, Samuelson, Allison, & Dent, 2000). Reflection also reduces the tendency to help specific victims (Small, Loewenstein, & Slovic, 2007). Developmental studies further support the idea that prosociality does not require complex reasoning – infants as young as 14 months show a tendency to spontaneously help others (Warneken & Tomasello, 2007).

Investigating behavior in PDs and PGGs, Rand et al. (2012) found consistent evidence that cooperation in social dilemmas occurred intuitively. This conclusion was based on both correlational studies of reaction times and studies where cognitive processes were experimentally manipulated. Across several correlational studies, faster reaction times predicted increased cooperation in both the PD and the PGG. Building on these correlational results, Rand and colleagues also experimentally manipulated the use of intuition and reflection. Encouraging participants to respond intuitively, either by requiring them to respond under time pressure or by cognitively priming an intuitive mindset, increased cooperation.

To explain the cognitive processes underlying intuitive cooperation, Rand and colleagues (2014) proposed the Social Heuristics Hypothesis (SHH). The premise of the SHH is that decision-makers tend to internalize strategies that are beneficial in their everyday social interactions. In the context of anonymous interactions, such as most laboratory experiments, the decision to cooperate with strangers may be costly and seemingly irrational. Yet, cooperation in real-life settings is both profitable and socially rational (Delton, Krasnow, Cosmides & Tooby, 2011; Krueger, DiDonato, & Freestone, 2012; Rand & Nowak, 2013), in part because real-life social dilemmas involve repeated interactions (Dal Bó, 2005), the opportunity to develop a

positive reputation (Feinberg, Willer, Stellar, & Keltner, 2012), and the threat of institutional sanctions for bad behavior.

Based on these positive experiences with real-life cooperation, decision-makers internalize cooperation as a heuristic response. Thus, when they are presented with a novel dilemma, the intuitive response is to apply the heuristic (e.g., cooperation). With reflection and careful consideration, the decision-maker may override the initial response and conclude that cooperation with strangers is unnecessary or ill-advised. This model is consistent with recent process-tracing studies, which found that decision-makers begin by focusing on cooperative, mutually beneficial outcomes and evaluate selfish strategies at a later stage in decision-making (Halevy & Chou, 2013).

Importantly, the SHH theory also identifies boundary conditions for when cooperation should not occur intuitively. For example, people who view their everyday interaction partners as untrustworthy should not be intuitively cooperative, because their daily life experiences do not reinforce cooperation as a successful strategy (Rand et al., 2012). Similarly, people with extensive experience participating in laboratory experiments have learned not to apply the internalized strategy of cooperation to one-shot interactions (Rand et al., 2014).

The inverted-U pattern of reaction times

To identify the mental processes underlying cooperation, researchers have conducted correlational studies of reaction times and experiments that manipulate cognitive processing. Reaction time correlations are an appealing method for distinguishing between intuitive and reflective processes, as reaction times are quantifiable and can be measured unobtrusively (Rubenstein, 2007). Consistent with experimental studies, which found that encouraging intuitive processing increased cooperation (Rand et al., 2014), several studies have reported a negative

correlation between reaction times and cooperation (Capellan et al., 2014; Lotito et al., 2013; Nielsen et al., 2014; Rand et al., 2012). However, counterexamples show that sometimes reaction times are *positively* correlated with cooperation. Piovesan and Wengström (2009) measured reaction times in dictator games where players chose from four allocations of wealth and found that selfish decisions were faster than prosocial ones. Fiedler et al. (2013) used eye-tracking to study the process of decision-making in binary choice dictator games and found that strictly self-interested individuals made decisions quickly, in part because they spent less time attending to the outcomes of other players, consistent with previous studies that focused on reaction times (Dehue, McClintock, & Liebrand, 1993; Liebrand & McClintock, 1988).

These conflicting correlational results may be explained by an inverted-U relationship between reaction times and cooperation. Studies from personality psychology have consistently found that reaction times to personality items follow a quadratic, inverted-U pattern (Akrami, Hedlund, & Ekehammar, 2007; Austin, 2009; Kupier, 1981). For scale-items measuring personality traits, responses that are close to either endpoint of the scale occur more quickly than responses near the scale midpoint. This pattern has been attributed to self-schema effects (Markus, 1977). When presented with a personality item, people respond to the item by comparing it to relevant self-information. People respond more quickly to the item when the relevant knowledge is clearly consistent (or inconsistent) with the item.

A similar reaction time pattern has also been observed in psychophysical tasks, where self-knowledge is not relevant (Mignault, Marley, & Chaudhuri, 2008). When judging the subjective properties of stimuli, e.g., comparing the similarity of two faces or evaluating the properties of a single face, reaction times followed the same quadratic pattern. Extreme judgments of similarity occurred more quickly than intermediate ones. The slow reaction times

associated with intermediate responses were related to the perceived uncertainty of the stimuli. When no clear response was evident, participants felt more uncertain and conflicted, and ultimately took longer to select the optimal response. These psychophysical results suggest that there may be a domain-general inverted-U pattern of reaction times.

Assuming that the inverted-U pattern of reaction times occurs in social dilemmas, the contradictory relationships between cooperation and reaction times observed in previous correlational studies could be explained by the relative frequencies of selfish, intermediate, and cooperative decisions. For example, in the correlational studies conducted by Rand et al. (2012), there were many participants who fully cooperated and relatively few who were fully selfish. Hence, the reported negative correlation between reaction times and cooperation could primarily reflect the difference between slow intermediate responses and fast cooperative responses. To address the possibility of a quadratic pattern, it is necessary to directly compare the reaction times of extremely selfish, intermediate, and extremely cooperative responses.

If, as we hypothesize, reaction times for cooperation decisions follow an inverted-U pattern, then it is necessary to reconsider the results of studies where the use of intuitive versus reflective processes was experimentally manipulated. One possibility is that intuition favors extreme, rather than cooperative, decisions. Alternatively, there may be a critical dissociation between correlational studies of reaction times and experimental manipulations of intuition and reflection. Additional psychological variables that extend beyond the dual-process framework may play an important role in determining reaction times. For example, slow reaction times may be associated with 'difficult' decisions. When the decider finds multiple options attractive, feelings of conflictedness may slow the process of decision-making and lead to the compromise

of an intermediate response. Thus our investigation has implications for research on the intuitive nature of prosociality, as well as the broader psychological interpretation of reaction times.

Overview of studies

The present report begins by investigating whether the inverted-U pattern of reaction times applies to the domain of cooperation in social dilemmas. We report two experiments and a meta-analysis of studies measuring reaction times and cooperation (Studies 1-3) to test if extreme, rather than cooperative, responses occur quickly. Next, we investigate whether the experimental manipulation of intuitive (vs reflective) processing generally leads to extreme (or cooperative) decisions with a meta-analysis of experiments that tests the effects of time pressure (Study 4). Finally, we investigate whether the additional psychological variable of conflictedness influences reaction times, above and beyond influences from intuitive or reflective processing. Studies 5 and 6 examine the effect of individual differences in feelings of conflictedness on reaction times and the tendency to provide extreme responses.

Studies 1 and 2

Studies 1 and 2 were initial tests of the hypothesis that extreme responses in social dilemmas occur more quickly than intermediate ones. We investigated the relationship between reaction times and the willingness to cooperate with a specific partner (PD; Study 1) and a group (PGG; Study 2). To test if reaction times were consistent across different response formats, participants made decisions using text boxes (Study 1) or slider bars (Study 2).

Study 2 also addressed the possibility that default, rather than extreme, responses were fast. Defaults are preselected, low-effort responses (Johnson & Goldstein, 2003). Changing a default influences whether a given response requires cognitive effort, as accepting the default is easier than selecting an alternative (Evans, Dillon, Krueger, & Goldin, 2011). In Study 2,

participants decided how much money to contribute to the group by moving a slider bar. The initial position of the slider bar was to contribute either nothing or everything. We hypothesized that extreme responses would occur quickly, regardless of whether the preselected default was to contribute everything or nothing.

Method

Study 1.

International participants were recruited from MTurk ($N = 324$, average age = 19.4; 45% women). 238 (73.5%) participants were native English speakers. The instructions for the Prisoners Dilemma (PD) were based on those presented in Yamagishi et al. (2013). Players were randomly assigned to partners and received 40 cents that they could keep or send to their partners. After reading the instructions, participants proceeded to a second screen where they provided their response by typing the amount of money they wished to send. The number of seconds spent on this screen was the measure of reaction time. After decisions were made, subjects completed a series of personality measures that were not analyzed in this report. One-in-ten participants were paid based on their decisions, and no deception was employed.

Study 2.

American participants were recruited from MTurk, $N = 253$. The average age of the sample was 31.45 ($SD = 9.9$) and 35% were women. In the PGG, players received 40 cents they could keep or contribute to the group. We manipulated whether the initial response was to contribute everything or nothing, with the slider bar always beginning at the leftmost position. We selected these default conditions because they provided an adverse test of the hypothesized pattern. One extreme response required no action, while the other required physical movement and cognitive effort (Evans et al., 2011).

At the beginning of the experiment, participants were presented with a page explaining the rules of the game. On the following page, participants provided a response using a slider bar. As in Study 1, the time spent on this screen was the measure of decision time. We also recorded the time spent reading the first page of instructions, noting that it was uncorrelated with decision times and contributions (p 's $> .20$). After providing a response, participants were asked two comprehension questions about the game. These questions were always presented after decisions had already been made to avoid priming reflective thinking (Rand et al., 2012). Most subjects (90%) answered both questions correctly. We analyzed the data of all participants, but note that excluding those with incorrect answers did not change the following results. Participants were paid based on their decisions and no deception was employed.

Results

Study 1.

Our analyses looked at the relationship between the level of cooperation and the number of seconds participants took to reach their decisions. In these studies, reaction times were log10 transformed to account for a heavily right-skewed distribution (Rand et al., 2012). In the PD, the average contribution was 19.6 out of 40 cents ($SD = 14.2$) and the average log-transformed reaction time was .91 ($SD = .25$).

To test the idea that extreme responses are fast, we partitioned decisions into one of three categories: selfish (contributing nothing), intermediate (contributing anything less than the full amount), or cooperative (contributing everything). There were 71 selfish decisions, 178 intermediate decisions, and 75 cooperative decisions. We used the nonparametric Mann-Whitney test to compare reaction times (See Figure 1 for average reaction times): Selfish responses were significantly faster than intermediate decisions, $Z = 4.6$, $p < .001$, $r = .29$; cooperative responses

were also faster than intermediate responses, $Z = 2.22$, $p = .026$, $r = .14$; and selfish responses were slightly faster than cooperative ones, $Z = 2.00$, $p = .045$, $r = .16$. Of course, the difference between selfish and cooperative responses may be due, in part, to the fact that selfish decisions required one fewer keystroke (typing “0” vs “40”).

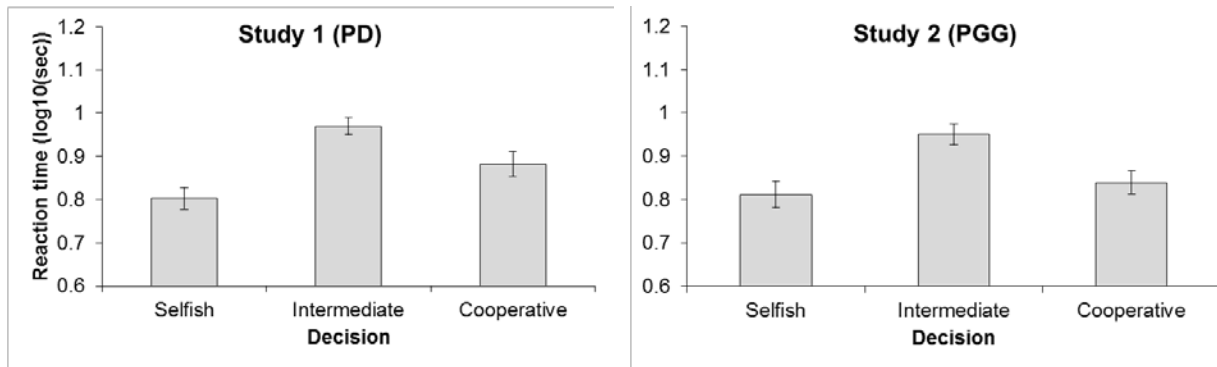


Figure 1. Reaction times in the Prisoners Dilemma (A) and Public Goods Game (B). Error bars denote the standard error of the mean.

Study 2.

In the PGG, the average log-transformed reaction time was .86 ($SD = .27$) and the average level of contribution was 22.5 cents of 40 ($SD = 16.7$). There were 59 selfish decisions, 95 intermediate decisions, and 75 cooperation decisions. As in Study 1, extreme responses were faster than intermediate ones: Selfish responses were significantly faster than intermediate choices, $Z = 3.52$, $p < .001$, $r = .28$; cooperative responses were also faster than intermediate choices, $Z = 3.6$, $p < .001$, $r = .26$; and there was no difference in the speed of selfish and cooperative choices, $Z = .51$, $p = .60$, $r = .04$.

Critically, these results did not change when we accounted for the manipulation of the preselected default. We compared extreme responses congruent with the default ($n = 79$; $M = .84$, $SD = .25$) with extreme responses that were contrary to the default, contributing everything when the default was to contribute nothing and vice versa, $n = 85$; $M = .82$, $SD = .28$, and found

no significant difference in speed, $Z = .78$, $p = .38$, $r = .06$. Although choosing the preselected default required no physical action, doing so was not associated with faster reaction times.

Study 3: Reaction time meta-analysis

In Studies 1 and 2, extreme, rather than cooperative, responses occurred quickly, evidence of the inverted-U pattern of reaction times. To test the generalizability of this result, we conducted a meta-analysis of studies investigating the relationship between reaction times and different levels of cooperation. This meta-analysis included several laboratory studies, allowing us to test whether the pattern extended beyond MTurk.

A second objective of our meta-analysis was to test the relationship between reaction times and cooperation across different levels of intermediate responses. In Studies 1 and 2, intermediate responses were collapsed into a single category, but previous studies on the inverted-U pattern of reaction times found a continuous, quadratic relationship between speed and proximity to the scale midpoint (Akrami et al., 2007; Austin, 2009).

Methods

We examined the relationship between reaction times and cooperation in a meta-analysis of 18 economic game experiments, with a total of 2,758 observations.

Although the studies varied in their details, each involved one-shot anonymous social dilemmas: participants received a cash endowment, and made a single decision about how much money to contribute in order to benefit one or more other anonymous others. Two studies measured dyadic cooperation and 16 measured cooperation in groups.

Six studies were run in the physical laboratory and twelve were run on MTurk. None of the studies involved any cognitive process manipulations (e.g. time pressure or cognitive load), which could alter decision times. This meta-analysis included Studies 1 and 2 from the present

manuscript, as well as the three correlational studies reported by Rand et al. (2012): Study 1, Study 10, and the Supplemental Study. See the appendix for a brief description of individual studies.

Our analyses looked at the relationship between decisions (selfish, intermediate, or cooperative) and log-transformed reaction times. All p -values were generated using linear regressions that controlled for study-level variation in cooperation, with a dummy variable included for each study.

Results

Pooling data across 18 studies, there were 588 selfish decisions, 1,216 intermediate decisions, and 960 cooperative decisions. The average rate of cooperation, scaled from 0 to 1, was .554 ($SD = .394$) and the average, log10 transformed decision time was .97 ($SD = .34$).

Comparing the reactions times of selfish, intermediate, and cooperative decisions, we found that intermediate responses were significantly slower than selfish ($t = 7.06, p < .0001$) and cooperative ($t = 7.04, p < .0001$) decisions. In addition, selfish decisions were slightly slower than cooperative choices ($t = 2.16, p = .031$). See Table 1 (Column 1) for the regression output.

| | Study 3 | Study 4: Time Pressure | Study 4: Time Delay |
|------------------------------|---------------------|---------------------------|------------------------|
| Selfish vs. intermediate | −.106 (.015) | −.090 (.010) | −.045 (.012) |
| Cooperative vs. intermediate | −.139 (.012) | −.107 (.008) | −.048 (.012) |
| Constant | .844 (.055) | .874 (.021) | 1.14 (.027) |
| Studies | 18 | 15 | 15 |
| Observations | 2,758 | 3,370 | 3,469 |
| Adjusted R ² | .277 | .454 | .078 |

Table 1: Multiple regressions were tested to compare the decision times of selfish, intermediate, and cooperative responses. Regressions were estimated for Study 3 and within the time pressure / time delay conditions of Study 4. Dummy variables were created for selfish and cooperative responses, treating intermediate responses as the reference group. Unstandardized beta weights are reported, with standard errors in parentheses. Values in bold were significant at $p < .001$.

When restricting our analyses to the 180 observations from the physical lab, we found that selfish decisions were faster than intermediate decisions, $b = -.18$, $SE = .047$, $t = 3.88$, $p < .001$; cooperative choices were also faster than intermediate choices, but not significantly so ($b = -.059$, $SE = .049$, $t = 1.21$, $p = .23$; and selfish choices were faster than cooperative choices, $t = 2.36$, $p = .019$. Predicted mean decision times for selfish, cooperative, and intermediate decisions are shown in Figure 2. This meta-analysis provides strong evidence that the pattern observed in the earlier correlational studies is robust and generalizable across different participant populations and experimental settings.

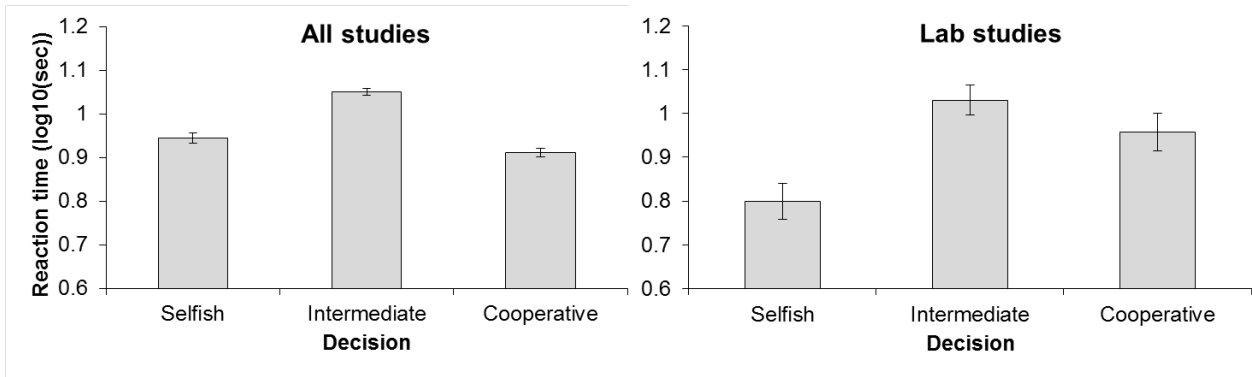


Figure 2. Predicted mean reaction times by cooperation amount over all studies (A) and in the physical lab (B).

Finally, we tested the relationship between reaction times and different levels of intermediate cooperation, focusing on the 1,216 intermediate decisions. We estimated a multiple regression predicting reaction times with the linear and quadratic levels of cooperation as predictors, with both variables centered on the midpoint response (.5). The linear-cooperation term tested if there was an overall positive or negative relationship between reaction times and cooperation. The quadratic term tested if reaction times were slower for intermediate decisions that were closer to the scale midpoint. The inverted-U pattern of reaction times predicts a *negative* coefficient for the quadratic effect of cooperation on reaction times. As with our previous analyses, dummy variables for each study were also included.

When restricting our analyses to intermediate decisions, we found no significant relationship between the level of cooperation and reaction times. There was no linear effect of cooperation on reaction times, unstandardized $b = -.03$, $SE = .04$, $t = .70$, $p = .48$, nor was there a significant quadratic effect, $b = .22$, $SE = .16$, $t = 1.38$, $p = .16$. In fact, the trend we observed was contrary to the predicted inverted-U pattern. Intermediate decisions that were closer to the scale midpoint were slightly *faster* than decisions that were closer to the scale endpoints.

Previous studies have found a continuous, quadratic relationship between response extremity and reaction time (Akrami et al., 2007; Austin, 2009), implying a gradual decrease in reaction times with increasing extremity. The inverted-U pattern in our studies, however, was driven by the speed of fully extreme responses. This pattern suggests a distinction between decisions meant to maximize singular motives, such as extreme selfishness or cooperation, and decisions meant to balance the conflicting motives of self-interest and the collective good.

Study 4 – Meta-analysis of effect of time pressure/delay on minimal and maximal cooperation

In Studies 1-3, extreme responses were faster than intermediate ones, raising the question of whether intuitive processing generally leads to extreme, rather than cooperative, behavior. Study 4 was a meta-analysis of experiments where cognitive processing was experimentally manipulated by forcing participants to respond intuitively (time pressure) or reflectively (time delay). We conducted two sets of analyses: First, we tested the effects of promoting intuition on the rates of selfish, intermediate, and cooperative responses. If intuition encourages extreme responses, then the rates of selfish and cooperative responses should both *increase* under time pressure. Or, if intuitive processing indeed promotes cooperation (Rand et al., 2014), then time pressure should increase the rate of cooperative responses and *decrease* the rate of selfish responses.

We also investigated if the inverted-U pattern of reaction times observed in our correlational studies was consistent within the pro-intuition (time pressure) and pro-reflection (time delay) conditions. If encouraging intuitive processing has no effect on the relative speed of extreme (vs intermediate) responses, this would suggest that reaction times are related to psychological variables other than the extent of intuitive or reflective processing.

Method

We considered the 6,913 cooperation decisions made under time pressure or time delay from the 15 studies analyzed in Rand et al. (2014). Each study involved a decision about how much one would be willing to contribute to give a greater benefit to one or more others, as well as an experimental manipulation of decision time. Participants were randomly assigned to either a time pressure condition (in which they were instructed to decide as quickly as possible, and typically given 10 seconds at most to decide) or a time delay condition (in which they were instructed to carefully consider their decision, and typically asked to stop and think for at least 10 seconds before deciding). See Rand et al. (2014) for further details.

To test the effects of time pressure on the probabilities of selfish, intermediate, and cooperative responses, we conducted three separate logistic regressions. These analyses included controls for study-level variation in cooperation. In all regressions, we included subjects that did not obey the time constraint to avoid selection effects, as per Tinghög et al. (2013).

Next, we examined the relationship between log-transformed reaction times and choices using linear regression, again including dummy variables for study-level variation in decision time. These analyses tested if the pattern of reaction times observed in our correlational studies was consistent within the experimental conditions that promoted intuitive and reflective processing.

Results

First, we examined the effect of time pressure on the rates of selfish, intermediate, and cooperative responses. If extreme, rather than cooperative, responses occur intuitively, we would expect the rates of selfish and cooperative decisions to increase under time pressure. However, we observed a different pattern of results (Table 2). Significantly *fewer* people selected selfish

responses under time pressure ($Z = -3.92, p < .001$). Conversely, significantly more people selected cooperative responses under time pressure compared to time delay ($Z = 2.45, p = .014$). Finally, time pressure had no significant effect on the probability of intermediate responses ($Z = .92, p = .356$). The predicted rates of decision category are shown in Figure 3A.

| | Selfish | Intermediate | Cooperative |
|---------------|--------------------|--------------|--------------------|
| Time pressure | -.25 (.061) | .058 (.052) | .128 (.053) |
| Constant | -.89 (.164) | .42 (.148) | -2.03 (.219) |

Table 2: *Logistic regressions were tested to compare the effects of time pressure (vs time delay) on the rates of selfish, intermediate, and cooperative decisions. Unstandardized beta weights are reported, with standard errors in parentheses. Values in bold are significant at $p < .05$.*

Next, we examined the relationship between extreme responses and decision time within the pro-intuition and pro-reflection conditions. Table 1 (Columns 2 and 3) reports the full regression outputs. As in the previous correlational studies, we observed that extreme decisions were made more quickly than intermediate decisions (Figure 3B). The pattern was consistent within the time pressure (selfish vs intermediate, $t = 8.78, p < .0001$; cooperative vs intermediate, $t = 12.47, p < .0001$; selfish vs cooperative, $t = 1.70, p = .089$) and time delay conditions (selfish vs intermediate, $t = 3.55, p < .001$; cooperative vs intermediate, $t = 4.37, p < .0001$; selfish vs cooperative, $t = -.21, p = .835$). Manipulating the use of intuitive (vs reflective) processing did not alter the relative speed difference between extreme and intermediate responses.

We did not find evidence of a causal relationship between use of intuition and extreme responses: experimentally manipulating decision time had no significant effect on the rate of intermediate decisions, but instead shifted participants from selfish to cooperative responses. Furthermore, the relative speed difference between extreme and intermediate decisions was

observed within both the time pressure and the time delay conditions. This suggests that additional variables, other than the extent of intuitive versus deliberative processing, contribute to the speed difference between extreme and intermediate responses.

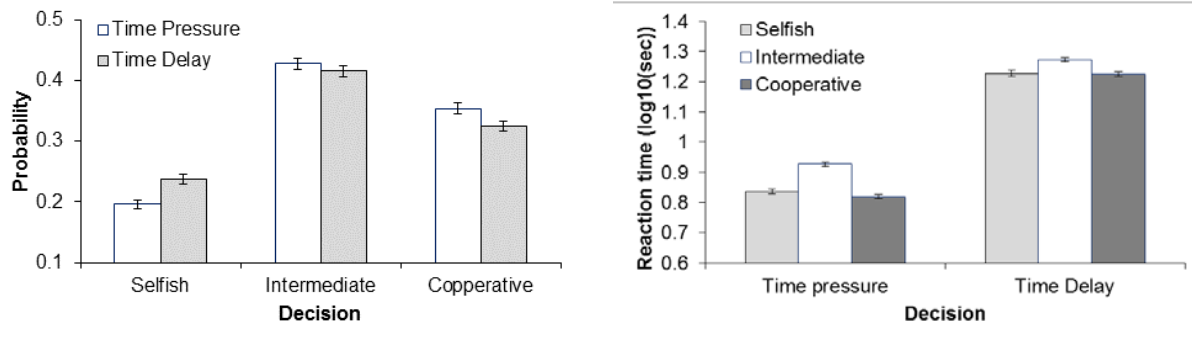


Figure 3. (A) Predicted probabilities of selfish, intermediate, and cooperative decisions under time pressure versus time delay. (B) Reaction times for selfish, intermediate, and cooperative decisions under time pressure and time delay conditions.

Study 5: Decision conflict and intermediate responses

Study 4 revealed that reaction times and cognitive process manipulations had different relationships with cooperative behavior. In Studies 1-3, selfish decisions occurred quickly, but encouraging participants to respond intuitively led to fewer selfish (and more cooperative) responses. In other words, extreme responses were fast, but not intuitive. Given these differing results, reaction times should not be taken as a direct proxy for the intuitive (or reflective) nature of a decision. Although speed and the use of intuition are undeniably related (Kahneman, 2011), reaction times may be influenced by additional psychological variables. The dual-process framework, by itself, is insufficient to explain the long reaction times of intermediate responses.

In Study 5, we sought to provide evidence for one such additional variable affecting reaction times: the level of conflict associated with the decision (Baron, Gürçay, Moore, Starcke, 2012). In perceptual tasks, difficult items are associated with greater conflict and longer reaction

times (Mignault, Bhaumik, & Chaudhuri, 2009; Mignault et al., 2008; Palmer, Nasman, & Wilson, 1994). Translating this idea to the domain of social dilemmas, we define the difficulty of a decision as corresponding to the absolute difference in preferences for self-interest and helping others. Decision-makers with strong preferences to behave selfishly or cooperatively should feel little conflict and quickly select one of the extreme responses. In contrast, those with uncertain or contradictory preferences should experience greater conflict, reach a decision more slowly, and be more likely to choose an intermediate response.

Method

We recruited 303 participants on MTurk to play a PGG. As in Study 2, the PGG was a single one-shot game involving four players. In this study, decisions were made using radio buttons in 10 cent increments. Task comprehension was assessed prior to playing the PGG. Of the 303 subjects, 273 correctly answered both questions. To avoid selection effects, our analysis includes all subjects, but our results are robust to excluding the participants with incorrect responses. Following the PGG, decision conflict was assessed by asking “How conflicted did you feel when making your decision?” using a 10-point Likert scale going from “Very little” to “Very much”.

Results

First, we attempted to replicate the reaction time pattern observed in previous studies. There were 103 selfish decisions, 63 intermediate decisions, and 163 cooperative decisions. Consistent with previous results, extreme responses occurred more quickly than intermediate ones, Mann-Whitney tests: selfish vs intermediate, $Z = 4.60$, $p < .001$, $r = .28$; cooperative vs intermediate, $Z = 4.4$, $p < .001$, $r = .29$; selfish vs cooperative, $Z = 1.00$, $p = .31$, $r = .07$ (See Figure 4A).

Next, we turned to decision conflict. The overall correlation between reaction times and self-reported conflict was significantly positive, $r(304) = .32, p < .001$, and feelings of conflict followed the same pattern observed with reaction times (Figure 4B): selfish vs intermediate, $t(163) = 3.20, p = .002, d = .50$; cooperative vs intermediate, $t(199) = 3.74, p = .0002, d = .53$; selfish vs cooperative, $t(238) = .54, p = .58, d = .07$. Intermediate responses were associated with greater conflict than extreme ones.

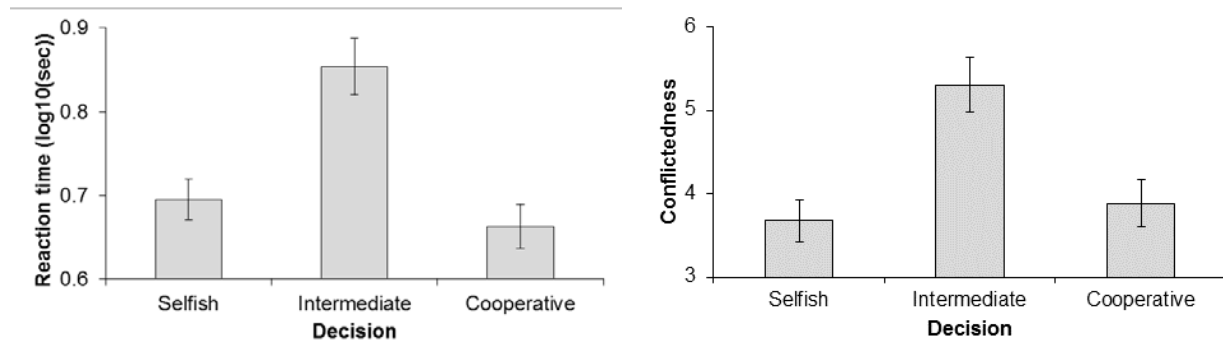


Figure 4. Reaction times (A) and conflictedness ratings (B) for selfish, intermediate, and cooperative responses.

We now ask if reaction times mediated the relationship between conflict and intermediate responses, testing a logistic mediational model using the bootstrapping method (Hayes, 2013). In this model, illustrated in Figure 5, self-reported conflict was the independent variable (X); log-transformed reaction time was the mediator (M); and decision category, intermediate vs extreme, was the dependent variable (Y). In this analysis, we combined fully selfish and fully cooperative decisions into a single category (intermediate = 1; extreme = 0). See Figure 5.

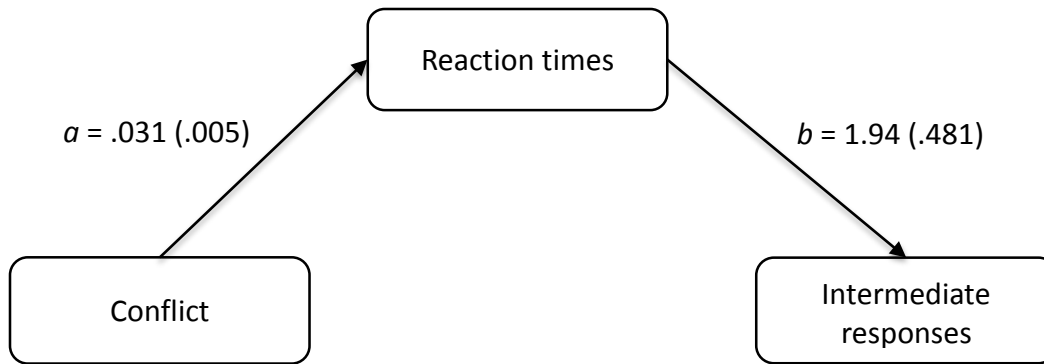


Figure 5. Bootstrapping was used to test whether reaction times mediated the relationship between decision conflict and intermediate decisions. Path coefficients report the unstandardized beta weights obtained from regressing decision time on self-reported conflict (*a*) and intermediate decisions on decision times (*b*).

The mediational model was estimated with 1,000 iterations using the PROCESS macro for SPSS. The estimated indirect effect of reaction time on intermediate responses was .049 ($SE = .019$) with a 95% confidence interval of .019 to .10. The confidence interval did not include zero, indicating that reaction times significantly mediated the effect of conflict on intermediate responses. Conflicted individuals took longer to reach a decision, and in turn, were more likely to select an intermediate option.

The estimated direct effect of decision conflict on intermediate responses was .13 ($SE = .052$) with a 95% confidence interval of .03 to .23. The confidence interval of the direct effect did not include zero, indicating that reaction times only *partially* mediated the relationship between conflict and extreme responses. It is important to note that although we treated conflict as the cause of slow decision times, the measure of conflict was taken after decision-making had already taken place. This ordering was necessary to prevent the measure from influencing response times or ultimate decisions, as response time measurement is highly sensitive to priming effects from pre-decision questions (See Rand et al., 2012, Supplemental Study).

We also considered an alternative model where conflict is caused by the time spent making a decision. Arguably, as the decider spends more time gathering and evaluating information, she becomes more likely to encounter conflicting or contradictory evidence. This alternative model states that feelings of conflict mediate the effect of reaction times on intermediate decisions. We find this alternative implausible given the results of Study 4, where we looked at the effects of experimentally manipulating reaction times. Forcing participants to respond quickly (vs slowly) had no effect on the rate of intermediate responses.

Study 6 – Reflection and decision conflict

In the previous study, we introduced feelings of conflictedness as an explanation for the speed of extreme responses. Study 6 tests if decision conflict is conceptually distinct from reflection. We viewed conflict and reflection as independent dimensions of decision-making, but an alternative hypothesis is that reflection, which involves the rational weighting of pros and cons, generally leads to higher levels of conflict. Hence, we tested if encouraging reflective decision-making led to greater feelings of conflict.

Study 6 also provides converging evidence on the effects of experimentally manipulating intuition and reflection. In Study 4, the meta-analysis of time pressure experiments, encouraging intuitive responding decreased the rate of selfish decisions and increased the rate of cooperative decisions. These results could be related to the incidental effects of manipulating time pressure, such as changes in mood or arousal. Hence, Study 6 manipulated the use of intuition (vs reflection) using a cognitive priming procedure.

Method

We performed novel analyses of an experiment originally reported as Study 8 of Rand et al. (2012). In this experiment, 864 participants completed a conceptual priming exercise, played

a one-shot PGG, and completed a demographics questionnaire. Participants were recruited from MTurk, with further details available in Rand et al. (2012).

The conceptual priming of intuition and reflection used an induction approach first introduced in Shenhav et al. (2011). In a 2 x 2 design, subjects were asked to write 8-10 sentences about a situation in which they adopted one of two cognitive approaches (intuition vs. reflection) and where that approach led to one of two outcome valences (positive vs. negative). For the present analyses, we compared the two conditions designed to promote reliance on intuition (the intuition-positive and reflection-negative conditions) with those promoting reflection (the intuition-negative and reflection-positive conditions). Of the 864 subjects, 343 wrote at least 8 sentences as instructed.

Following this induction, subjects played a one-shot PGG. The rules of the PGG were similar to those reported in previous studies. Unfortunately, reaction times for the PGG were not recorded in this study. After deciding how much money to contribute to the group, subjects completed the same decision conflict measure used in Study 5; data from this measure was not previously analyzed.

Results

Rand et al. (2012) focused on the 343 subjects that wrote at least 8 sentences, and found that cooperation was higher in the conditions that promoted intuition relative to reflection, $t(341) = 2.44, p = .015, d = .26$. Participants primed with intuition contributed more money to the group ($M = 25.6$ cents out of 40, $SD = 15.6$) than those primed with reflection ($M = 21.4, SD = 16.3$). We found that this result was also obtained when analyzing data from all 864 participants, $t(862) = 2.86, p = .004, d = .19$. To avoid possible selection effects, all of our subsequent analyses included all 864 observations.

Next, we tested the relationship between contributions and feelings of conflictedness. We replicated the finding from Study 5 that intermediate decisions involved more conflict ($M = 5.22$, $SD = 2.64$) than both selfish ($M = 4.70$, $SD = 2.99$) and cooperative ($M = 3.89$, $SD = 3.08$) decisions, t-tests: selfish vs intermediate, $t(554) = 1.96$, $p = .05$, $d = .16$; cooperative vs intermediate, $t(724) = 6.25$, $p < .001$, $d = .46$; selfish vs cooperative, $t(444) = 2.57$, $p = .010$, $d = .24$.

Our central question was whether the use of intuition vs reflection directly influenced feelings of conflictedness. Levels of conflict were similar in the pro-intuition ($M = 4.79$, $SD = 2.9$) and pro-reflection ($M = 4.54$, $SD = 2.87$) conditions, $t(862) = 1.27$, $p = .21$, $d = .08$. Encouraging the use of intuition versus reflection had no significant effect on decision conflict. In fact, feelings of conflict were slightly lower in the pro-reflection conditions, allaying the concern that conflict is related to the degree of reflection.

Next, we tested whether time pressure and cognitively manipulating intuition had similar effects on behavior. Recall that in Study 4, encouraging intuition through time pressure decreased the rate of selfish responses and increased the rate of cooperative responses. To replicate this analysis, we estimated separate logistic regressions to measure the effects of priming intuition on the rates of selfish, intermediate, and cooperative responses. The results of the regression are reported in Table 3.

| | Selfish | Intermediate | Cooperative |
|-----------|---------------------|--------------|--------------------|
| Intuition | −.692 (.192) | −.054 (.136) | .458 (.143) |
| Constant | −1.35 (.120) | −.037 (.097) | −.830 (.105) |

Table 3: Logistic regressions were tested to compare the effects of priming intuition (vs reflection) on the rates of selfish, intermediate, and cooperative decisions. Unstandardized beta weights are reported, with standard errors in parentheses. Values in bold are significant at $p = .001$.

Consistent with our meta-analyses of time pressure experiments, priming intuition significantly decreased the likelihood of selfish responses ($Z = 3.60, p < .001$), had no effect on the likelihood of intermediate responses ($Z = .40, p = .69$), and significantly increased the likelihood of cooperative responses ($Z = 3.20, p = .001$). The results are visualized in Figure 6. As in Study 4, experimentally priming decision-makers to favor intuitive processing shifted participants from selfish to cooperative responses.

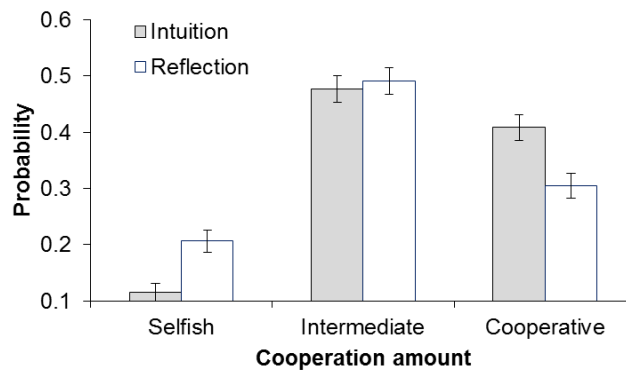


Figure 6. Effect of conceptual priming intuition (vs reflection) on the rates of selfish, intermediate, and cooperative decisions.

General Discussion

Previous studies have produced conflicting results as to whether reaction times are positively (Piovesan & Wengström, 2009) or negatively (Capellan et al., 2014; Lotito et al., 2013; Nielsen et al., 2014; Rand et al., 2012) correlated with prosocial behavior. In the present report, we attempted to reconcile this difference with the hypothesis that extreme, rather than cooperative, decisions occur quickly. Two new experiments and a meta-analysis of reaction times in social dilemmas consistently found evidence of an inverted-U relationship between reaction times and cooperation: both selfish and cooperative decisions occurred more quickly than intermediate responses. This pattern was found in economic games measuring dyadic and group cooperation, was robust to different response formats, and was observed in both MTurk and laboratory samples. The pattern occurred even when participants were forced to respond quickly or delay their responses.

Although reaction times are sometimes interpreted as a veridical indicator of the degree of reflection, the pattern of reaction times observed in Studies 1-3 was different from the effects of experimentally manipulating intuitive or reflective processing. Forcing participants to respond intuitively through time pressure (Study 4) or cognitive priming (Study 6) decreased the rate of selfish decisions, had no effect on the rate of intermediate decisions, and increased the rate of cooperative decisions. These experimental results are consistent with the conclusion that cooperation is, in fact, intuitive (Rand et al., 2014). Given this discrepancy, decision times should not be treated as a direct proxy for the degree of reflection, as other psychological variables may also influence decision speed.

Studies 5 and 6 developed the idea that individual differences in conflictedness, rather than reflection, led to longer response times and intermediate decisions. Across both studies, selfish and cooperative decisions were associated with less conflict than intermediate decisions.

In Study 5, participants who felt conflicted about their decisions in the PGG took longer to respond and, in turn, were more likely to choose intermediate responses – reaction times significantly mediated the relationship between conflict and intermediate responses. Study 6 tested the effects of cognitively priming intuition and reflection on feelings of conflict. The behavioral effects of priming intuition were similar to the effects of time pressure. Critically, priming intuitive processing did not influence self-reported decision conflict, demonstrating the independence of these two psychological variables.

Cooperation and the Social Heuristics Hypothesis

Consistent with the SHH, we found that promoting intuition increased the frequency of cooperative decisions, but decreased the frequency of selfish decisions. Moreover, our studies further clarified the effects of intuitive and reflective cognitive styles in social dilemmas. The use of intuition versus reflection predicted the tendency to select extremely cooperative (or extremely selfish) responses, but did not predict the tendency to select intermediate responses. This suggests that the tendency to approach decisions intuitively (vs reflectively) influences the salience of specific social norms or decision rules that correspond with extreme responses. However, because manipulating cognitive processing did not affect the frequency of intermediate responses, the dual-process framework, by itself, may be insufficient to explain the tendency to select intermediate responses or to account for differences across different levels of intermediate cooperation. Other variables, such as feelings of conflictedness, also play an important role in the process of decision-making.

Decision conflict and reaction times

The idea that conflictedness is associated with longer reaction times is similar to results from perceptual (Mignault et al., 2009) and moral judgment tasks (Baron et al., 2012), but our

work is the first to identify its existence in the domain of social dilemmas. We defined conflictedness as the difference in preferences for self-interest versus the collective good. Our studies, however, did not directly address the specific individual and situational factors that contribute to conflictedness. Such feelings may be related to the dispositional differences in self-interest and altruistic concerns (Gerbasí & Prentice, 2013); whether the situation is perceived as strong or weak (Snyder & Ickes, 1983); or the specific costs and benefits associated with cooperation (Rand & Kraft-Todd, 2013). Identifying the antecedents of decision conflict in social dilemmas is an important consideration for future research.

In Study 5, there was a moderate, positive correlation between conflictedness and reaction times, allowing for the possibility that other psychological factors also influence the speed of decision-making. We view conflictedness as one of several variables that contribute to individual differences in reaction times. Slow reaction times may also be related to individual differences in mood and arousal (Buodo, Sarlo, & Palomba, 2002), specific emotions involving approach and avoidance (Marsh, Ambady, & Kleck, 2005), and prior experience with social dilemmas (Rand et al., 2014). Future research is needed to develop a comprehensive model of the individual differences that influence reaction times. As our studies suggest, researchers should be careful in interpreting the psychological significance of reaction times.

Reaction times in social dilemmas

The central result of Studies 1-3 was that extreme responses were significantly faster than intermediate choices. This finding was similar to the inverted-U pattern of reaction times observed in other domains. However, unlike previous studies in other domains which found a continuous, quadratic relationship between response extremity and fast reaction times (Akrami et al., 2007; Austin, 2009), the pattern of reaction times in social dilemmas was driven by the speed

of extremely selfish and extremely cooperative responses. In Study 3, when we focused on only intermediate decisions, there was no quadratic (or linear) relationship between reaction times and different levels of cooperation. This suggests a critical distinction between decisions attributable to a single motive or decision rule, such as maximizing self-interest or the collective good, and responses that involve some attempt to balance conflicting goals.

The primary focus of our studies was the distinction between extreme and intermediate decisions, but we also observed variation in the relative speeds of selfish and cooperative decisions. The meta-analysis of 2,758 cooperation decisions (Study 3) found that cooperative choices were slightly faster, on average, than selfish ones. In some cases, however, we observed a significant difference in the opposite direction, as in Study 1 and the six laboratory experiments reported in Study 3. Overall, these differences were generally small and could have arisen due to differences in how participants provided responses. Text boxes, for example, favor fast selfish decisions by requiring only one keystroke for selfish decisions.

In tasks where there is an objectively correct answer, fast decision-makers are more likely to give incorrect responses (Rubenstein, 2013). This raises the possibility that fast responses in social dilemmas are due to carelessness. Given the present studies, we find this explanation unlikely – note that in Study 2, fast responses could not be explained by adherence to the pre-selected default response. Interestingly, the two extreme responses, contributing everything or nothing to the group, were optimal responses for participants motivated to maximize the collective good or self-interest, respectively (Van Lange, 1999). Fast decision-makers were more likely to make choices that were individually or socially rational (Delton et al., 2011; Krueger et al., 2012; Rand & Nowak, 2013).

Concluding remarks

Understanding the cognitive processes underlying human cooperation is an important goal for researchers in the fields of social psychology and behavioral economics (Rand & Nowak, 2013; Van Lange et al., 2013; Zaki & Mitchell, 2013). We found further support for the idea that cooperation is intuitive and selfishness requires reflection. However, we also revealed an important dissociation between correlational analyses of reaction times and experimental manipulations of cognitive processes. In our studies, selfish decisions were fast, but not intuitive. These results have important implications for how researchers and decision-makers interpret reaction times and the underlying cognitive processes that influence cooperation in social dilemmas.

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Appendix

| Study | Recruitment | Game | Payoff description | N | Other notes |
|-------|------------------|---------------|---|-----|---|
| A | Harvard CLER lab | PGG | 20 unit endowment, contributions multiplied by 1.6 and split among 4 group members; 50 units = \$1 | 28 | First round of an unknown number of one-shot stranger matching PGGs |
| B | Harvard HDSL lab | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 24 | First round of 15 one-shot stranger matching PGGs |
| C | Harvard HDSL lab | PGG | 20 unit endowment, contributions multiplied by 1.6 and split among 4 group members; 50 units = \$1 | 24 | First round of 15 one-shot stranger matching PGGs |
| D | Harvard HDSL lab | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 10 units = \$1 | 24 | |
| E | Harvard HDSL lab | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 10 units = \$1 | 32 | |
| F | Harvard HDSL lab | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 10 units = \$1 | 48 | |
| G | MTurk | PD | 40 unit endowment, contributions multiplied by 2 and given to a partner, 100 units = \$1 | 324 | Data from Study 1 of the present report |
| H | MTurk | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 253 | Data from Study 2 of the present report |
| I | MTurk | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 212 | Data from Rand et al 2012 Nature Study 1 |
| J | MTurk | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 341 | Data from Rand et al 2012 Nature Study 10 |
| K | MTurk | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 72 | Data from Rand et al 2012 Nature Supplemental Study |
| L | MTurk | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 189 | Data from Amir et al 2012 PLoS ONE |
| M | MTurk | Trust Game P1 | P1 chose how much of 40 units to transfer to P2; any transfer was tripled. P2 then decided how to return. 100 units = \$1 | 195 | Data from Amir et al 2012 PLoS ONE |
| N | MTurk | PGG | 20 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 475 | Framed as extraction rather than contribution |
| O | MTurk | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 63 | |
| P | MTurk | Trust Game P1 | P1 chose how much of 40 units to transfer to P2; any transfer was tripled. P2 then decided how to return. 100 units = \$1 | 102 | |
| Q | MTurk | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 158 | |
| R | MTurk | PGG | 40 unit endowment, contributions multiplied by 2 and split among 4 group members; 100 units = \$1 | 200 | |

Table A1: Summary of studies included in the meta-analysis of reaction times and cooperation

(Study 3).